

## ASEPTIC FILLING METHOD

BACKGROUND OF THE INVENTIONTechnical Field

5 [0001] The present invention relates to a method for aseptically filling tea or the like beverage in a container.

Prior Art

[0002] Bottle-shaped synthetic resin containers (e.g., PET bottles or the like), in which tea or the like beverage is packed as the content, successfully obtained wide support by consumers due to recent tea boom, and its market tends to be progressively expanded. It is important in particular that the contents preserve the natural taste and flavor thereof, and thus desirable to suppress the influence of temperature change of the contents as low as possible. Consequently, so-called aseptic (i.e., abacterial) filling system has been adopted, in which the contents are sterilized and cooled within a short time, and then packed in a sterilized container at normal temperature.

[0003] The container used for the aseptic filling is assumed to pack the contents at normal temperature, after having been subjected to sterilization and cooling, and therefore the heat resistance of the container has not been specifically taken into consideration. However, when the contents together with the container are heated, for example, to 65°C by a warmer, hot vender or the like during cold months, such as in winter season, it is likely that the container is deformed by heat thereby degrading the commercial value.

[0004] In this respect, trials have been made such as to replace the container used for aseptic filling with a container having improved heat resistance adopted for hot filling, or to increase the wall thickness of the container. However, even in the case of containers with improved heat resistance, the body portion has a heat resistance that is still insufficient for heating by a warmer or the like, while the increased wall thickness of the container is not very desirable from the viewpoint of reduction of resources.

30 DISCLOSURE OF THE INVENTION

[0005] It is therefore an object of the present invention to provide a novel aseptic filling method by which the container filled with the contents can be effectively prevented from deformation upon heating.

[0006] To this end, according to the present invention, there is provided a filling method wherein the contents preliminarily sterilized are subjected to aseptically filled in a synthetic resin container subjected to rinsing and sterilization, and wherein the contents are filled under a temperature which is higher than normal temperature, 5 but lower than a hot filling temperature intended for sterilization effect, i.e., a temperature for expressing sterilization effect (about 80°C or higher). Here, the term "normal temperature" generally denotes a predetermined standard temperature condition as prescribed in JIS Z 8703 or corresponding ISO 554: 1976: "*Standard Atmospheres For Conditioning and/or Testing*", i.e., a temperature at about 20°C, 10 and this applies to the present application as well.

[0007] It is preferred that the temperature of the contents upon filling is within a range of 30°C to 40°C. However, when a cooling step for cooling the filled contents to normal temperature is added as the final step of the aseptic filling method, the contents upon filling may be at a temperature achieved by heating by means of a 15 warmer or the like heater, for example, at a temperature within a range of about 50°C to 60°C.

BEST MODE FOR CARRYING OUT THE INVENTION

[0008] The aseptic filling method according to the present invention will be more fully described below.

[0009] Although various systems have been proposed with respect to aseptic filling, one example will be explained below. There is known a system wherein a container sterilizing section is combined with an aseptic filling section. In this case, the inside of a bottle, which has been produced by blow-molding process or the like, is rinsed with warm water at the container sterilizing section, the outside of the bottle 25 is then rinsed with a sterilizing solution using the mouth portion of the bottle as a target, the inside of the bottle is sterilized by being fully packed with a sterilizing solution, the sterilizing solution is discharged and aseptic air flushing is carried out with the mouth portion of the bottle directed downwards. At the subsequent aseptic filling section, the contents are aseptically filled in the bottle to which the aseptic air 30 flushing has been carried out, followed by capping treatment.

[0010] It has been conventionally considered that, when liquid is packed in a container through the above-described aseptic filling method and such container is heated by a warmer or the like, the shape deformation of the container by thermal

influence upon heating would be inevitable. However, according to the present invention, the thermal influence with respect to the container upon heating can be effectively mitigated by maintaining, upon aseptic filling, the contents at a temperature that is higher than normal temperature, but lower than a temperature expressing the sterilization effect, preferably at a temperature within a range of 30°C to 40°C. By this, the shape and appearance of the container (hence, the commercial value) are positively prevented from degradation.

[0011] The reason why the container is prevented from deformation in shape and degradation in appearance by maintaining the content at a temperature higher than normal temperature and carrying out the aseptic filling will be explained below. Thus, when the contents maintained at a temperature higher than normal temperature are filled, the final inner pressure in the container is lower as compared to the case of carrying out the aseptic filling under normal temperature condition. Therefore, even if the container is heated in such conditions, it would be possible to suppress increase in the inner pressure upon heating, by the decreased amount of the inner pressure.

[0012] The above-mentioned mechanism will be more fully clarified below. When 280 ml of water is aseptically packed at normal temperature (20°C) and at 40°C in PET bottles having a full volume of 290 ml (residual space in the bottle is 10 ml), the inner pressure of the bottle is as below. Further, upon consideration of the influence of the inner pressure to the bottle, it is assumed that the container is rigid for ignoring the mitigation of the pressure caused by deformation of the container, when the level of increase in the inner pressure is calculated, and the change of the volume caused by thermal expansion of the container is also assumed to be negligible.

[0013] First of all, 280 ml of water at 20°C changes its volume to 281.69 ml at 40°C and 285.04 ml at 65°C caused by thermal expansion. It is assumed that the gas in the space of the container follows the state equation of ideal gas:  $PV = nRT$ . Since the water vapor pressure is 2.338 kPa at 20°C, 7.377 kPa at 40°C and 25.014 kPa at 65 °C, the difference in water vapor pressure upon heating from 20°C to 65°C is about 23 kPa ( $25.014 - 2.338 = 22.676$ ), and the difference in water vapor pressure upon heating from 40°C to 65°C is about 18 kPa ( $25.014 - 7.377 = 17.637$ ).

[0014] When the container is packed at 20°C and then heated to 65°C, namely,

when it is aseptically packed according to conventional process and heated, the pressure in the space within the container is determined by:

$$PV = nRT$$

$$P'V' = nRT'.$$

5 Here, n and R are constants, P = 101.325 kPa (pressure at filling = atmospheric pressure), V = 10 ml (the residual space volume within container upon filling), T = 293 K (absolute temperature at filling 20 + 273), P' = pressure of space in container upon heating, V' = 290 - 285.04 = 4.96 ml (the residual space volume within the container upon heating), T' = 338 K (the absolute temperature upon heating; 65 + 273). In this instance, since  $PV/T = P'V'/T'$ , the pressure P' in the space within the container upon heating is:

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$$\begin{aligned} P' &= PVT'/TV' \\ &= (101.325 \times 10 \times 338)/(293 \times 4.96) \\ &= 236 \text{ kPa.} \end{aligned}$$

15 Further, when 23 kPa of the difference in water vapor pressure is added, the final inner pressure (absolute pressure) is  $236 + 23 = 259$  kPa (158 kPa by gauge pressure).  
[0015] On the other hand, when the container is packed at 40°C and heated to 65°C, namely, when it is aseptically packed according to the present invention and then heated, the pressure in the space within the container is similarly determined in 20 the manner as described above. Here, P = 101.325 kPa (the pressure upon filling = atmospheric pressure), V = 8.31 ml (the residual space volume within the container upon filling 280 ml of water at 20°C and maintained at 40°C), T = 313 K (the absolute temperature upon filling 40 + 273), P' = the pressure in the space of the container at heating, V' = 290 - 285.04 = 4.96 ml (the residual space volume within 25 the container upon heating), T' = 338 K (the absolute temperature upon heating 65 + 273). Accordingly, the pressure P' in the space of the container upon heating is

$$\begin{aligned} P' &= PVT'/TV' \\ &= (101.325 \times 8.31 \times 338)/(313 \times 4.96) \\ &= 183 \text{ kPa.} \end{aligned}$$

30 When 18 kPa of the difference in water vapor pressure is added, the final inner pressure (absolute pressure) is  $183 + 18 = 201$  kPa (100 kPa by gauge pressure).  
[0016] As described above, the difference of the inner pressure between the filling at normal temperature (20°C) and the filling at 40°C is  $158 - 100 = 58$  kPa by

gauge pressure, and the difference of the inner pressure is considered to be a factor capable of suppressing the shape deformation of the container when the container subjected to aseptic filling is heated. As a matter of fact, since the inner pressure is mitigated by the elastic deformation of the container, it becomes further low pressure.

5 [0017] In general, a warmer or the like heater is used so as to maintain the content in the container at a temperature of about 50°C to 60°C. Accordingly, from the viewpoint of suppressing increase in the inner pressure of the container upon heating, it would be best to pack the content under the similar temperature as the heating temperature at the aseptic filling. In this case, it is preferred to add a  
10 cooling step for cooling the content to normal temperature as the final step of the aseptic filling process. Alternatively, when the installation of a cooling device and extension of the cooling line are undesirable, it is preferred that the upper limit temperature of the content is kept at about 30°C to 40°C during the aseptic filling, i.e., at the temperature capable of suppressing deformation of the container without  
15 requiring the cooling step.

#### Verification Experiments

20 [0018] In order to confirm advantageous effects of the present invention, circular-sectioned heat resistive PET bottles with a shrink label having a filling volume of 280 ml (the amount of the resin used: 26 g), and square-sectioned highly heat resistive PET bottles with a shrink label having a filling volume of 350 ml (the amount of the resin used: 26 g) were prepared, water at 20°C and water at 40°C were charged in the respective containers, caps were fastened and then the changes in shape and appearance were observed when they were heated in a water bath, i.e., immersed in respective isothermal water vessels at 60°C, 65°C, 70°C, 75°C and  
25 80°C for 1 hour.

30 [0019] The result of the experiments is shown in Table 1. Further, the appearances of the containers were evaluated by judging according to the situations of the convex portions at the bottom portions and panel portions (body portions) of the containers when they are cooled to normal temperature. Symbol “x” indicates a case of generating projections on the convex portions of bottom portions and the panel portions after cooling, symbol “△” indicates a case of generating projections on the slight convex portions of bottom portions and the panel portions after cooling, symbol “○” indicates a case that practically negligible slight convexes were

generated on the bottom portions, and symbol “◎” indicates a case of generating no problems at all.

[0020]

Table 1

Test temperature (°C)	Circular-sectioned heat resistive PET bottle of 280 ml		Square-sectioned heat resistive PET bottle of 350 ml	
	Filling at 20°C	Filling at 40°C	Filling at 20°C	Filling at 40°C
85	×	×	×	×
75	×	×	△	○
70	-	-	○	◎
65	○	○	○	○
60	○	○	-	-

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[0021] As clearly shown in Table 1, it could be confirmed that the change in shape of the container is significantly suppressed by maintaining the contents at a higher temperature than normal temperature upon aseptic filling, the circular-sectioned heat resistive PET bottle can withstand the heating to about 60°C and the square-sectioned heat resistive PET bottle can withstand the heating to about 65°C.

[0022] It will be appreciated from the foregoing detailed description that, according to the present invention, since the aseptic filling is carried out by setting the temperature of the contents at a level higher than normal temperature, the temperature upon heating approaches to the temperature at filling as compared to the case of filling at normal temperature and the increase in the inner pressure of the container upon heating is mitigated. Therefore, even if the contents are heated together with the container, it is possible to effectively and significantly suppress the influence degrading the shape and appearance of the container.

[0023] While the present invention has been described above with reference to the preferred embodiments, it is needless to say that various modifications from the embodiments described above may be adopted without deviating from the scope of the invention.